

WRIT 1301

10 October 2018

### Poisonous Plastics

Plastic is ubiquitous. We live in a world dominated by plastic and for good reason: plastic has many redeeming qualities. It is inexpensive, easy-to-manufacture, and extremely versatile. For these reasons, plastic is used in the food industry quite frequently. It is almost impossible to visit a grocery store nowadays and not see food wrapped with, sealed in, or touching plastic. Not to mention, plastic is also present in unexpected places such as the coatings on paper-packaged food products and the linings of tin or aluminum cans. Despite its widespread use, most people do not actually know what plastic is made of or the health risks associated with its use. Plastic contains hazardous chemicals that can leach into food while being heated up or during storage. Thus, it would be wise to remove plastics from your daily life in order to reduce the dangers of plastic exposure from heating up and storing food.

In order to understand the health risk associated with plastics, it is essential to understand their composition. Every plastic is classified as a polymer, a material made of many tiny pieces called monomers. Plastic is much like Legos where every brick is a monomer and the entire stack of bricks is the polymer. All plastics have a base monomer, the monomer that the majority of the polymer is made of. However, plastics that are made of just one monomer usually lack favorable properties. Thus, in order to give a plastic some desirable qualities, other monomers, called additives, are added to the mixture. Additives are commonly added to improve elasticity, durability, ability to withstand heat, and so forth. However, these additives “are not chemically bound to the polymer molecules and can, therefore, move freely within the polymer matrix” (Helmroth et al 1). Consequently, the additives can leave the packaging and enter the food along

the food-plastic interface. Some of the common additives with adverse health effects are phthalates, bisphenols, and alkylphenols. The major concern with these additives is that they “are considered [to be] Endocrine Disruptors” (Fasano et al 132). The health consequences from exposure to such chemicals can influence reproduction and development in humans because the absorbed additive monomers act as functional hormones. It is also known that additives cause “other modes of endocrine disruption in addition to binding to estrogen receptors, such as alterations in endogenous hormone synthesis, hormone metabolism and hormone concentrations in blood” (Vom et al 4). Due to the hazardous properties of additives, situations in which additives could transfer to your food should be avoided.

There are many ways plastic additives can enter your food. One major pathway of additive transfer is heating up the plastic. For example, microwaving leftovers in a plastic container or pouring hot coffee into a Styrofoam cup are situations in which monomers would leach into food. Each type of plastic has a certain temperature at which it becomes very easy for the additive monomers to migrate from the plastic into your food. All of these temperatures are easily achieved using a microwave or boiling water. Although it may not always seem as if your food has reached this temperature, analysis of microwaved food has shown that the areas of direct contact with the plastic and food reach these critical temperatures, especially if there are fats present (Bhunia et al 536). The mechanism responsible for the increased monomer migration is increased reaction kinetics. In this instance, reaction kinetics can be understood as monomer movement within the polymer. Hence, as a result of the additive monomers having the ability to freely move through the plastic, when the temperature of the plastic in contact with the food “increases, the diffusion of monomers, oligomers, and other compounds increases, and it can result in higher diffusion or rates of migration from packaging materials” (530). Higher diffusion rates of additive monomers

equate to more monomers leaching into the food that it is touching. Thus, it is best to avoid heating up food in plastic containers.

Another large contributor to monomer migration is contact time. Storing food in plastic containers, wrapping food in plastic wrap, or even buying meat on foam trays are all ways that additives can be transferred to your food. Other less obvious ways that monomers can be transferred to food during storage include polymer coatings on the inside of aluminum cans and foil chip bags. Regardless of the situation, monomers can be transferred to food any time there is contact between the food and plastic. The reaction mechanism for this kind of transfer is often very slow; however, in the instance of food storage, the slow diffusion rate is compensated for with time. The longer the plastic and food are in contact, the more additives end up in the food. For example, an experiment involving monomer migration from a plastic lining into the bag's contents showed that the "[m]igration of [additives] ranged from 57 to 74% of the original [additive] content in the packaging after 4 months storage" (Aurela et al 1). Contact time is not the only factor that contributes to monomer migration during storage. Plastics can also experience stresses during long term storage that increase monomer migration. An example of a common stress experienced by plastic during food storage is swelling; over time liquids resting in a plastic container absorb into the polymer which "causes swelling of the polymer matrix, thereby enlarging the gaps and increasing additive migration rates" (Helmroth et al 103). The increased rate of migration results in more additives in the stored food. Thus, if food is to be stored for a long period of time, it is best that it is stored in glass or metal containers to eliminate the transfer of additive monomers into the stored food.

Some may argue that the quantity of additives that migrate into food is negligible. This viewpoint originates from the method by which most toxicology studies are carried out. It is

common practice in toxicology studies to perform tests with high concentrations of toxin and extrapolate its effects to lower concentrations using a linear relationship. This practice ignores the fact that receptor-mediated reactions, such as those of hormones, have a saturation limit. This means that after a certain concentration the response is the same regardless of the dose concentration, rendering the extrapolation from higher concentrations invalid. In fact, a “wide range of adverse effects at ‘low doses’ that are below the US-EPA reference dose in animals” are seen in lab testing with the same results that one would see at higher concentration (Vom et al 4). Hence, due to the current methods of toxicology studies, the “current risk assessment assumptions [show] a dramatic underestimation of responses (and thus risk) associated with exposure to low doses of [additives]” (Welshons et al 1003). Therefore, it is in your best interest to be mindful of even the smallest of additive concentrations as it poses a threat to your health.

In addition to the belief that small concentrations of additive are trivial, another misconception with plastics is that additive monomers are harmless due to an apparent lack of symptoms. The fallacy in this logic is best elucidated with an example from recent history: the use of asbestos. Before the danger associated with asbestos was known, asbestos was used as an insulation material in the majority of the buildings prior to 1980. After many years of its use as a building material, it was discovered that asbestos is very carcinogenic, serving a huge risk to those who have it in their homes. Plastic is analogous to asbestos in that it has widespread use and the general population is not yet aware of its dangers. However, the impact of plastics on health are beginning to be discovered just as the carcinogenicity of asbestos was discovered in the mid-twentieth century. In fact, it has been found that “recent trends in human disease relate to adverse effects observed in experimental animals exposed to low doses of [additive monomers]” (Vom et al 12). In other words, lab animals exposed to additive monomers experienced some of the same

health issues seen in the United States currently. Some specific examples include an increase in “prostate and breast cancer, uro-genital abnormalities in male babies, a decline in semen quality in men, [and] early onset of puberty in girls” (12). Thus, just as those with asbestos exposure experienced the effects later in life, the population of the United States will experience the effects from plastic monomers even more in the years to come as evident by the recent trends in health now. With this in mind, you should learn from asbestos that ubiquity does not imply safety and remove plastics from your daily life.

Although the abundant plastics of today’s modern world may appear harmless, they often hide health hazards, like additives, beneath their surface. Polymer additives can lead to many complications of the endocrine system, causing abnormal hormonal responses. These effects are seen at even the smallest of concentrations. Thus, it would be of best practice to eliminate the use of plastic where reasonable in everyday life. Luckily, two of the most significant contributors to monomer migration, heating and storing food in plastic, are easily avoidable. A simple change like microwaving food with a ceramic plate or storing food in glassware can begin to cut down toxin exposure. Examining where you use plastic in your life and changing what is reasonable is the key to reducing exposure to the harmful chemicals residing in plastic.

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